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The aging effect: The relationship of twist to structural and mechanical remodeling of the left ventricle in a normal population using HARP CMRI

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Background

Left ventricular (LV) twist increases with age but the relationship of changes in twist to the structural and mechanical remodeling of the heart that occurs during normal aging is unknown.

Purpose

In a population of carefully screened normal volunteers aged 26-91 years, we compared CMR LV structure and function and blood pressure to tagged CMR torsion, twist, circumferential systolic strain and strain rate to determine the correlates of changes in twist with age.

Methods

Forty-one normal volunteers were prospectively recruited. Subjects were nonobese, nondiabetic, normotensive and free of cardiovascular history or significant valvular or myocardial disease by screening echocardiography. After volumetric short axis retrospectively gated SSFP cine imaging (1.5 T Siemens Avanto), breath-hold retrospectively gated short axis tagged gradient echo cines were acquired in LV base, midventricular, and apical slices with a nominal FOV 21 × 28 cm, matrix 108 × 144, 6 mm slice thickness, grid tag distance of 8 mm, TE 3.8 ms, TR 58 ms, temporal resolution 35 ms. Tagged images were analyzed using HARP software (Diagnosoft).

Results

Of 41 individuals, 23 were females. The group was divided by age into tertiles. Twist increased with age>60 years while LV end systolic volume (LVESV) decreased, with associated increases in ejection fraction (LVEF), systolic blood pressure (SBP) and pulse pressure (PP). End diastolic volume (LVEDV), LV mass, systolic circumferential strain and strain rate did not change with age so that LV Mass/ESV ratio increased (Table 1).

In addition to aging, increased twist was also associated with smaller LVEDV ($r = 0.350$, $p = 0.02$), smaller LVESV ($r = 0.317$, $p = 0.04$), increased LV mass/LVEDV ratio ($r = 0.400$, $p = 0.01$), slower average systolic strain rate ($r = 0.341$, $p = 0.03$), faster average early diastolic strain rate ($r = -0.427$, $p = 0.01$), and increased pulse pressure ($r = 0.308$, $p = 0.005$). Twist was not associated with LVEF ($r = 0.033$, $p = 0.83$) and LV mass ($r = 0.155$, $p = 0.33$). In stepwise regression analysis, pulse pressure ($r^2 = .262$, $p = < 0.01$) and LVESV ($r^2 = .353$, $p = 0.03$) were the strongest independent predictors of age, and were not interdependent ($p = 0.17$).

Conclusion

In normal subjects LV twist increases with age as arterial pressure increases and mild LV concentric remodeling occurs. Twist is more sensitive than strain, strain rate or ejection fraction to aging effects.

Table 1: Comparison of left ventricular structure and function in tertile age groups

	Group 1: 37.8 ± 6.5 years	**Group 2: 51.3 ± 3.1 years**	**Group 3: 72.0 ± 8.9 years**	
	Mean ± SD	**Mean ± SD**	**Mean ± SD**	**p value**
LVEDV	137.3 ± 48.1	126.8 ± 49.8	126.7 ± 36.9	0.81
LVESV	70.8 ± 17.5	63.5 ± 25.4	50.9 ± 19.4	0.06
LVEF	50.2 ± 13.8	53.1 ± 11.8	60.7 ± 6.1	0.05
SBP	114 ± 9	126 ± 15	136 ± 18	<0.01
PP	46 ± 7	53 ± 12	64 ± 13	<0.01
LV Mass	80.3 ± 23.0	80.9 ± 34.6	82.9 ± 27.8	0.97
LV Mass/LVESV	1.2 ± 0.3	1.4 ± 0.6	1.7 ± 0.4	0.01
Twist	-13.1 ± 3.5	-11.4 ± 3.6	-16.1 ± 3.4	0.02
Systolic strain rate	-98.5 ± 11.4	-93.4 ± 13.7	-94.5 ± 12.5	0.41
Early diastolic strain rate	232.9 ± 89.7	214.2 ± 105.9	211.2 ± 95.2	0.82
Systolic strain	-18.8 ± 2.1	-17.7 ± 2.2	-17.6 ± 1.5	0.13